gelatine 2 ft. from us should check those discussions which we foolishly carry on over the wounds we inflict.

All my hospital transplantations are treated as out-patients, and return to their homes on the day of operation, and no difficulties of any kind arise therefrom.

With the limited time at my disposal, I have thought it best not to discuss individual operations nor to dwell upon statistics. I have preferred to lay before you certain principles which I hope may prove useful. Both arthrodesis and tendon transplantation are, if properly appreciated and applied, valued surgical assets. They give us an interest and encouragement in our treatment of paralytics which we sorely needed. Failures, and we are bound to experience many, should prove our welcome counsellors, and we should be unsparing of our efforts to learn from them all we can.

THE MOST ANCIENT SPLINTS.

BY

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[WITH SPECIAL PLATE]

IT is a well-known fact that among the ancient Egyptians excellent results were often obtained in the treatment of fractured bones, but it has never been explained what measures the archaic surgeons adopted to secure this success in the practice of their art.

I have been fortunate enough to have had the opportunity of examining two sets of splints which had been applied to fractured limbs almost at the dawn of Egyptian history—roughly, about five thousand years ago. These are certainly the oldest splints which have come to light in any part of the world, and, with the exception of flint knives used for circumcision* in Egypt in prehistoric times, they are the earliest surgical appliances ever discovered.

These interesting objects were found by the Hearst Egyptian Expedition of the University of California in charge of Dr. George A. Reisner. The enlightened generosity of Mrs. Phœbe Hearst, the great benefactor of that institution, has enabled Dr. Reisner to make scientific investigation rather than the mere collecting of museum exhibits the paramount object of the work of the expedition; and to the thoroughness with which this aim has been pursued we are indebted for the discovery of these splints, which throw a new light on the early history of surgery.

During the progress of the Hearst Expedition's work at Naga-ed-dêr (about 100 miles north of Luxor), Mr. A. C. Mace excavated a cemetery of rock-cut tombs made in the time of the fifth dynasty.† In these tombs were found the two sets of splints which form the subject of these notes.

By one of those curious coincidences which occur at times in the experience of every one who systematically examines large series of specimens, both of these sets of splints—the only known splints that had been applied to living‡ patients earlier than the Christian era§—were found at the same time and in one cemetery. These sets of splints have been in the Anatomical Museum of the Cairo School of Medicine for the last five years, and, although they have been seen by innumerable visitors, no account of them has ever been published, because it was our intention to reserve the description of them for the reports of the Hearst Expedition's work. But at the urgent recommendation of Mr. Edmund Owen I have sought and obtained permission from Dr. Reisner to publish these notes and photographs now.

Mr. Mace's photographs showing the condition of the two tombs from which these splints came will be published in the Hearst Expedition's Reports, and one of these showing the splints themselves *in situ* is reproduced here to illustrate the exact position in which they were found (Fig. 1). One of the sets of splints I replaced in the exact position in which they were found (and photographed by Mr. Mace) for the purpose of taking the photograph reproduced here as Fig. 2. In the case of the second set of splints their linen wrappings have become so stiff and brittle after five years in a museum show-case that they cannot be put into their original places without damaging the bandages. The manner in which they are shown in Fig. 3, however, is perhaps more instructive. It shows the position of the bones in relation to the splints and it is easy to imagine the exact appearance of the supporting pieces of bark when they were put together to form a tube around the damaged limb.

SPLINTS APPLIED TO A COMPOUND FRACTURE OF THE FEMUR.

This case is the fracture of the shaft of the right femur almost exactly at its mid-point; the subject was a girl about 14 years of age. A piece of bone 52 mm. long and 13 mm. wide had been detached from the back of the shaft at the seat of the fracture (Fig. 4). As this was missing and also for other reasons to be mentioned later the fracture must have been compound.

The broken limb was set with four splints passing from just above the fracture to a point well below the knee (Figs. 2 and 3). Each consisted of a rough, slender strip of wood, which had been wrapped up by means of a carefully-applied linen bandage (Fig. 5, B) before being fixed to the limb. The splints were held in position by means of two bandages, each tied in a reef knot (Figs. 2, 3, and 5, A), one above and the other below the knee. As the result of a natural process of decomposition and, even to a greater degree, of the damage done by insects, the great part of the linen bandages has disappeared, and even what is left of them is in a very much disintegrated condition and is very fragile. Sufficient remains, however, to indicate exactly what had been done by the surgeon to prepare and apply the splints. The most important and most carefully prepared splint was applied to the antero-mesial aspect of the limb (Fig. 2; in Fig. 3 it is to the right side of the bone). It consists of a rough strip of wood, which has been sawn or roughly shaped with an adze, but not planed. It is 40.3 cm. (about 1 ft. 4 in.) in length, 2.9 cm. (about 1¼ in.) in width, and 7 mm. (about ¼ in.) in thickness. Only 7.2 cm. (less than 3 in.) of this splint was above the seat of the fracture, but 16 cm. of its length was below the knee.

It was carefully wrapped in two layers of linen bandage, wound obliquely around the wood in such a manner that the direction of the obliquity of the superficial layer was at right angles to that of the deeper layer (Fig. 5, B). The bandage is 3.5 cm. (about 1⅜ in.) broad, and is composed of somewhat loosely and irregularly-woven threads, of which there are 14 per cm. in the warp and 32 in the woof.

A short distance below the site of the fracture there is a large pad of linen, 8 cm. long and 3.1 cm. thick, attached to this splint; its upper border is 9 cm. from the upper end of the splint (Figs. 2 and 3). This pad is composed for the most part of a bandage, wound in a circular manner around the splint, but on its inner aspect there is an unattached sheet of linen, folded to form an oblong mass (55 × 35 mm.).

The femoral surface of this pad is discoloured by a rust-like stain, which my own investigations, and especially the large series of exact observations made by Mr. Frederic Wood Jones, M.B., my collaborator in the anthropological work in Nubia, enable me to recognize as

* In my examination of the bodies found in the prehistoric cemetery at Naga-ed-dêr (Hearst Expedition's excavations), I found that all the men were circumcised. In a tomb of the ancient empire at Sakkara, the operation of circumcision is represented in a series of wall pictures; the surgeon is using a flint knife. Although it is not possible to say with certainty that any particular knife found in an archaic tomb has actually been used for surgical purposes, it is safe to say that some of them were intended for such a use.

† There are still great discrepancies in the estimates of the dates of these ancient Egyptian dynasties. Professor Breasted, following the Berlin school of archaeologists (which reduces the periods of time to the lowest possible figure), gives the date of the fifth dynasty as 2730-2625 B.C. Professor Flinders Petrie gives the date as 3721-3503 B.C. Even if we adopt the lowest estimate of age, these splints are more than 4,500 years old.

‡ I have described (Report on the Unrolling of the Mummies of the Kings Siptah, Seti II, Rameses IV, Rameses V, and Rameses VI, *Bulletin de l'Institut Egyptien*, 8e Série, T. 1, 1907, p. 49) a set of splints applied to the right forearm of King Siptah of the nineteenth dynasty, which had been broken by plunderers of his mummy long after his death and was set with splints by the priests of the twenty-first dynasty, who rewrapped his body, which the robbers had stripped.

§ I have described sets of splints found on the two forearms of a girl of the early Christian period (perhaps seventh century). See the first *Bulletin of the Archaeological Survey of Nubia*, 1908. Mr. Mace tells me that in an early Christian cemetery at Naga-ed-dêr, excavated by the Hearst Expedition, he found a fractured patella set with splints. This is now in one of a large series of boxes (in the Anatomical Museum of the Cairo School of Medicine) which have not yet been unpacked.

blood.* The surface of the shaft of the femur from the seat of the fracture as far down as the centre of this pad exhibits similar evidence of blood staining.

That such stains should last is very surprising, seeing that my colleague, Professor W. A. Schmidt, is unable to obtain any chemical or biological reaction of blood from these specimens or in any samples of blood staining more than 250 years old.[1] The circumstances in which Mr. Wood Jones and I have found these stains in several hundred cases prove that they are undoubtedly blood. Professor Schmidt and Mr. W. M. Colles have obtained iron from such stains, and they tell me that even after the complete disintegration of blood the iron left will persist and stain the bones and other structures.

These circumstances go to prove that the fracture was a compound one, and that the pad on the antero-mesial splint was placed on the wound.

The postero-mesial splint (Fig. 3, on the extreme right) is a rough strip of unsawn and unplaned wood, which is rendered still more irregular by several small knots. It is the same length as the splint already described, 27 mm. wide, and has a maximum thickness of 9 mm. It is wrapped in linen like the rest.

The antero-lateral splint (Figs. 2 and 3) resembles the antero-mesial in shape and size. It was roughly shaped by means of an adze. In its present state this splint is broken across at the place where it rested on the external condyle of the femur (Fig. 2). This probably occurred at the time the skeleton collapsed after the decomposition of the flesh; the fragile, worm-eaten piece of wood dropped on the femur, while the weight of a mass of tomb clothes would fall on its two ends, thus snapping it. This strip of wood was wrapped like the others.

The postero-lateral splint (Fig. 3, the extreme left) is a very roughly split piece of irregularly knotted wood, 36 cm. long and 22 mm. wide. It was wrapped like the others.

Death must have occurred very soon after the damage was inflicted on the limb, for there is no evidence of any inflammatory or healing reaction on the broken bone except a very slight roughness on the anterior surface of the lower fragment.

That these splints must have been quite useless as a support to the broken bone or as a restraint on the tendency of the thigh muscles to shorten the limb, is obvious at a glance. Their only purpose could have been to fix the knee-joint, and by that means to ensure some degree of rest to the damaged member.

A

Fig. 5.—A, Knot in bandage tied around the splints. B, Part of the postero-mesial splint, to show the manner of covering the wood with bandages.

The examination of a series of healed fractures of the femur obtained from ancient Egyptian tombs shows—what in fact we might have anticipated from a study of these splints—that as a rule there is considerable shortening, displacement of the fragments, and an excessive development of callus.

SPLINTS APPLIED TO A COMPOUND FRACTURE OF THE FOREARM.

In this case there is a fracture of both bones of the left forearm at about its mid-point, the ulna being broken a little below and the radius a little above the middle of their respective shafts (Fig. 6). The fracture was certainly compound, because there is a pad of blood-stained vegetable fibre (probably obtained from the date palm) still adherent to the upper fragment of the ulna (Fig. 7) and bandages; this was evidently pushed into the wound to stanch the bleeding; some of this palm fibre is still sticking to the broken surface of the bone, and extends into its medullary cavity. A complete tube of splinting invested the damaged limb from a point about an inch below the upper end of the radius as far as and partly including the wrist-joint. This tube consisted of three pieces of rough bark (probably acacia) and a bundle of straws of coarse grass (Fig. 7).

The broken arm was probably treated in the following manner: The wound was plugged with the vegetable fibre to which I have already referred. Then the forearm was invested with a bandage, 76 mm. (less than 3¼ in.) wide, composed of linen of a much finer mesh (warp 22 and woof 35 threads per centimetre) and more closely-woven than that used in the other case. Small fragments of bandage still adherent to the bark seem to show that these splints were wrapped in linen, like those applied to the thigh, but there is not sufficient left to exhibit their arrangement. The splints have a natural curve, which must have adapted itself accurately to the form of the limb. Two of the pieces of bark were of the same size—26 cm. (about 10¼ in.) long and 22 mm. broad (measured without allowing for the curve)—but the third splint was considerably shorter (19.5 cm.). When these three splints had been applied, a gap, 25 mm. wide, was left between two of them behind the ulna. This space was then filled in with a bundle of coarse grass, placed directly upon the bandage investing the arm (Fig. 7). Then a broad sheet of linen, reaching from the upper ends of the splints as far as the wrist, was wrapped around the complete tube of splinting, and then two tapes, each 18 mm. wide, composed of a folded bandage, were applied and presumably tied around the whole investment of the limb.

Death occurred soon after the infliction of the injury, because there is no sign of any healing process.

As an effective support to the broken bone, these splints present a marked contrast to those found on the thigh, and the examination of the excellent results obtained in the treatment of the large series of healed fractures of the forearm which I have studied, shows that the measures adopted by the ancient Egyptian surgeon admirably served their intended purpose. I have seen only one case of long-standing ununited fracture of the ulna; and, in spite of the fact that a certain proportion of the cases of fracture (always due to direct violence) must have been compound, only one of my series (of more than 100 examples) shows any signs of suppuration having occurred. Even in prehistoric times fracture of the ulna alone usually healed with little or no displacement or shortening, and with a remarkably small development of callus, but in such cases the undamaged radius may have fulfilled the functions of a splint. In a case of fracture (Fig. 8) of both bones of the forearm recently found in a very early prehistoric cemetery in Nubia (see Wood Jones's report in the second *Bulletin of the Archaeological Survey of Nubia*) there is not only considerable displacement of both broken bones, but also evidence which seems to indicate that the fractures remained ununited for some time before eventually healing. Whether or not splints were used in prehistoric times in Egypt is a question we cannot answer with certainty; but it is safe to say that no such splints as I have described in this communication could have been used in the case to which I have just referred, for it exhibits in its displacement, delayed union, and its outgrowth of callus all the signs which Sir William Macewen has taught us to associate with free mobility combined with tearing of the periosteum.[2]

Fracture of the forearm—as a rule the left ulna, but

* Appended to the present communication there is a report by Mr. Wood Jones on the subject of blood stains on ancient bones.

often both bones, and sometimes in both arms—has always been exceedingly common in Egypt in comparison with the incidence of other fractures. This is true of every period from the earliest known prehistoric times up till the present. The Egyptians have always indulged in fencing, both as an amusement and also as a serious method of attack; for both purposes they use the *naboot*, a very thick, heavy stick about 5 ft. long, which many Egyptian peasants habitually carry. No doubt the great majority of these fractures of the forearm were inflicted while the victim, with upraised arm, was defending himself or herself; for a considerable number of women, especially in prehistoric times, have suffered from this injury. In the Anatomical Museum in the Cairo School of Medicine there is an example of such a fracture of the left forearm in a girl of the time of the twenty-sixth dynasty (about 600 B.C.), whose bodily remains bear distinct traces, not only of the manner in which the injury was inflicted, but also of a possible reason for the fatal attack which had been made upon her. She was a young woman less than 20 years of age and in the sixth month

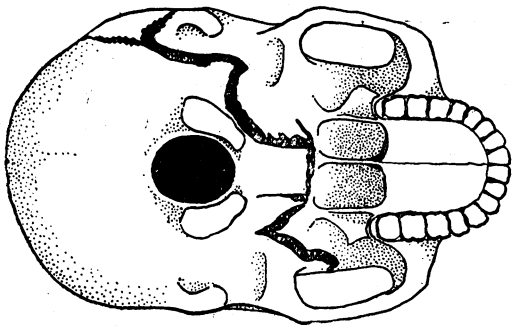

Fig. 3.—Diagram to show the opening of the sutures at the base of the skull. (Illustrating Dr. Wood Jones's paper, p. 736.)

of pregnancy; just when her condition was making itself evident she was murdered by a series of blows, one on the left forearm, another on the left shoulder breaking the acromion process, and others, the fatal blows, smashing the left side of the jaw, face, and cranium.* There is, perhaps, no such common motive for murder in Egypt at the present day as the discovery by a father or brother of delinquency on the part of a daughter or sister. This case seems to have been an ancient instance of a drama of daily occurrence in Egypt to-day.

There is one curious feature common to both sets of splints described in this communication, and that is, unlike the general usage of modern European surgeons, the old Egyptian employed more than two splints. In other words, he endeavoured to form a protective casing around the damaged limb to guard it against injury from outside rather than to hold the fragments of bone rigidly in position, and so avoid the greater danger of damage from within. It is a striking testimony to the stability of this idea, as well as of the extreme conservatism of the Egyptian, that three thousand years later he was using exactly the same form of appliance. I have recently described sets of splints found around the broken forearms of a young Christian woman, who was buried on an island near Philae in the 7th century A.D.[3] Five rough wooden splints were applied around one of these damaged limbs.

In the year 1903 an expedition was sent by the Egyptian Ministry of Public Works to Lake Tsana in Abyssinia. On its return Mr. Hayes, the Medical Officer to the Expedition, told me that when they crossed into Abyssinia patients flocked to him from all the surrounding country; among them was a man wearing splints on a broken forearm which resembled those used in Egypt five thousand years before.†

Gorgy effendi Sobhy, Demonstrator of Anatomy in my department, tells me that the use of such splints as I have described in these notes is still widely prevalent in Egypt, although the rapid increase in the number of medical men trained by European methods and in accordance with Western ideas, and also the improvement in the education of the village barber-surgeons, threaten the extinction of this form of splint, which has been in vogue here for the past five thousand years. He informs me that most of the barbers, when they do not refer cases of fracture to a medical practitioner, make use of a pair of splints after the European model; but in most villages there are old women ready to take upon themselves the treatment of fractures. They make a kind of mat of a number of pieces of palm-stick (the axis of the leaf of a date palm) laid side by side, and wrap the broken limb in this, so as to form a tube around it like that found in the second case described above. Dr. Gorgy tells me that there is a much-venerated relic of an early Christian monk in one of the churches of Old Cairo with such a splint in position on a broken arm.

The modern Egyptian bonesetter uses the same type of

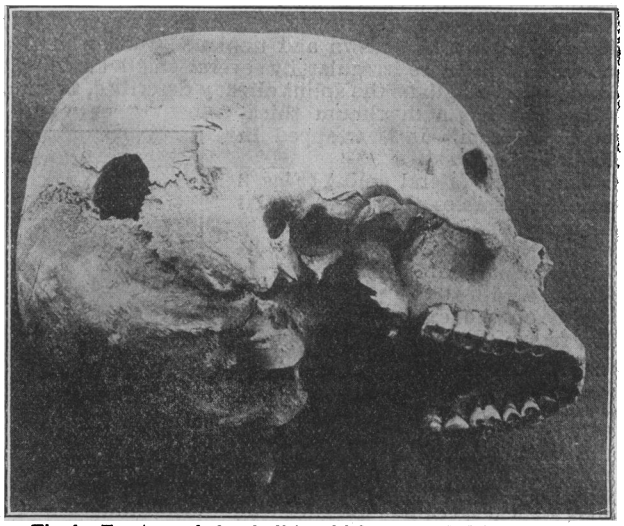

Fig 4.—Fracture of the skull in which a rounded fragment was found inside the cranial cavity. (Illustrating Dr. Wood Jones's paper, p. 736.)

splint, but very often he uses a series of strips of rough wood instead of palm sticks.

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[1] Chemische und biologische Untersuchungen von ägyptischen Mumienmaterial, *Zeitschrift für allgemeine Physiologie*, Bd. 7, 1907, p. 374. [2] Sir William Macewen, The Rôle of the Various Elements in the Development and Regeneration of Bone, *Philosophical Transactions*, 1907, p. 260. [3] *Archaeological Survey of Nubia, Bulletin No. 1*, 1908.

THE POST-MORTEM STAINING OF BONE PRODUCED BY THE ANTE-MORTEM SHEDDING OF BLOOD.*

BY FREDERIC WOOD JONES, M.B.LOND.

[WITH SPECIAL PLATE.]

IN 1905, when Dr. Elliot Smith was engaged on the work of unwrapping the royal mummies at the Cairo Museum, he discovered in the body of Rameses V an *ante-mortem* wound of the skull, and around the wound he saw and described "a wide area of discoloration."[1] Although from this discoloration Professor W. A. Schmidt was unable to obtain any blood reactions, there is practically no doubt that it was in reality due to blood. The blood that causes the staining is only to be identified by blood tests for a certain lengthy period after its shedding, and 250 years is the limit of age of blood stains from which positive reactions have been obtained. It is therefore not surprising that the blood of Rameses V failed to show the blood reactions.

In the anthropological work of the Egyptian Government Archaeological Survey of Nubia, Dr. Elliot Smith and I have come to recognize that, though the stains of ancient blood may not be amenable to laboratory treatment, still they are, none the less, signs of the utmost importance in the diagnosis of *ante-mortem* wounding, even in the most

* I unrolled this mummy two years ago in the presence of Sir A. W. Simpson, Emeritus Professor of Midwifery in the University of Edinburgh. Before we had any idea as to what was about to be revealed I told Professor Simpson, in answer to his query, that I had never seen the mummy of a pregnant woman.

† Unfortunately these splints were not brought away from Abyssinia, and I have only the verbal account of them given me by Mr. Hayes, who at that time had neither seen nor heard of the ancient splints in the museum of my department.

* An account of the circumstances which have made such an investigation as this possible will be found in the first *Bulletin of the Archaeological Survey of Nubia*. This note is published with the permission of the Egyptian Ministry of Finance and Captain H. G. Lyons, F.R.S., Director-General of the Survey Department, under whose direction the Archaeological Survey of the country to be flooded, when the Assouan dam is raised, is being carried out. For the determination of the age of the materials used in this investigation I am indebted to Dr. George A. Reisner, who conducted all the excavations and the archaeological work of the expedition.

TO ILLUSTRATE DR. G. ELLIOT SMITH'S PAPER ON ANCIENT SPLINTS.

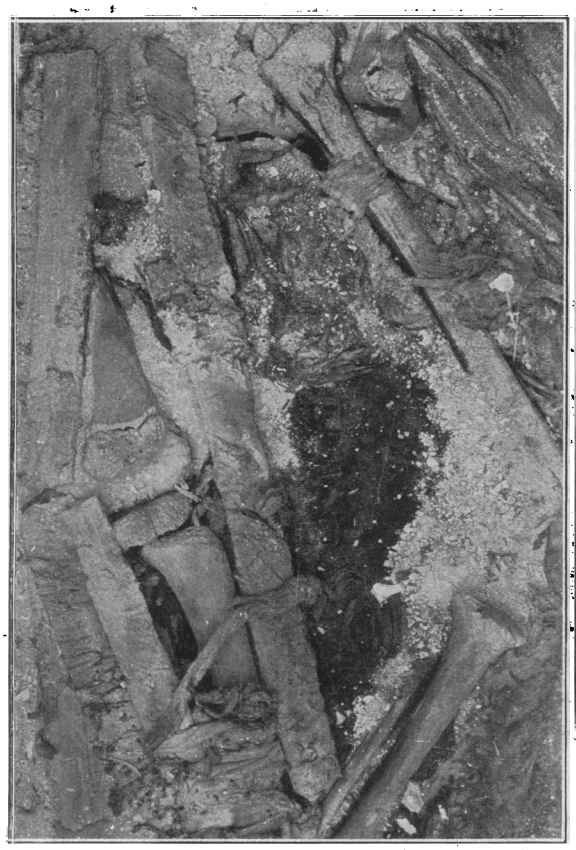

Fig. 1.—Photograph by Mr. Mace of splints as found *in situ* in the tomb.

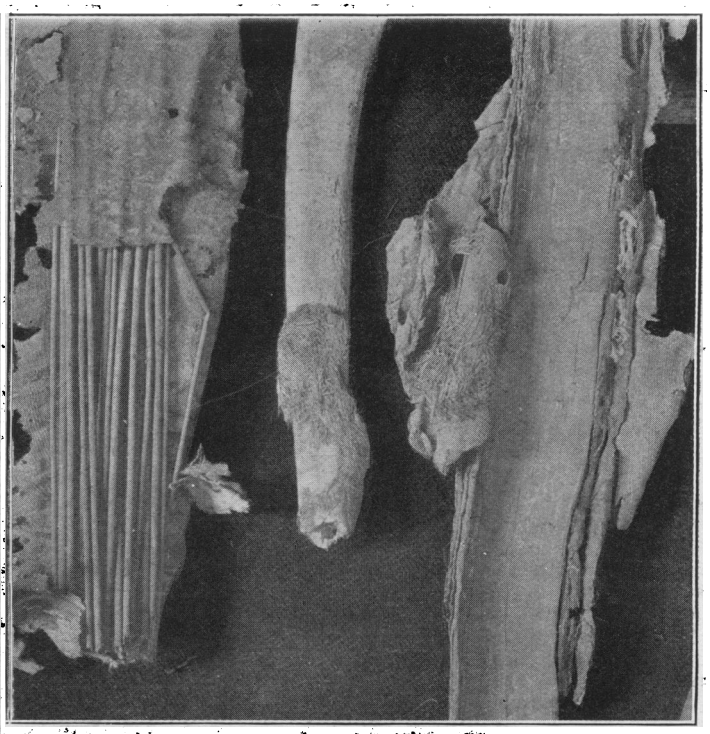

Fig. 7.—The upper fragment of the ulna with a mass of palm fibre adhering to it. On the right, one of the bark splints with blood-stained palm fibre adhering to its linen wrapping; on the left, one end of the bundle of grass reeds seen from behind. Note the linen both in front of and behind the reeds.

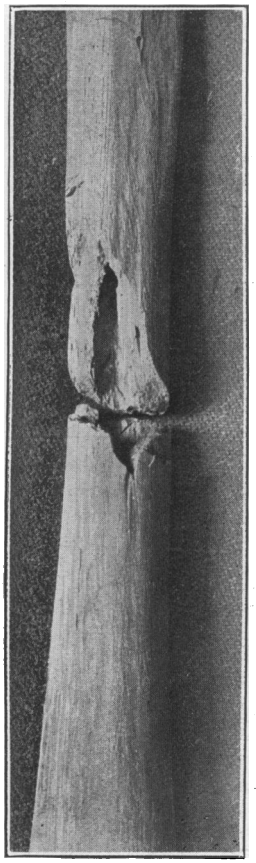

Fig. 4.—The broken femur seen from behind, showing oss of substance.

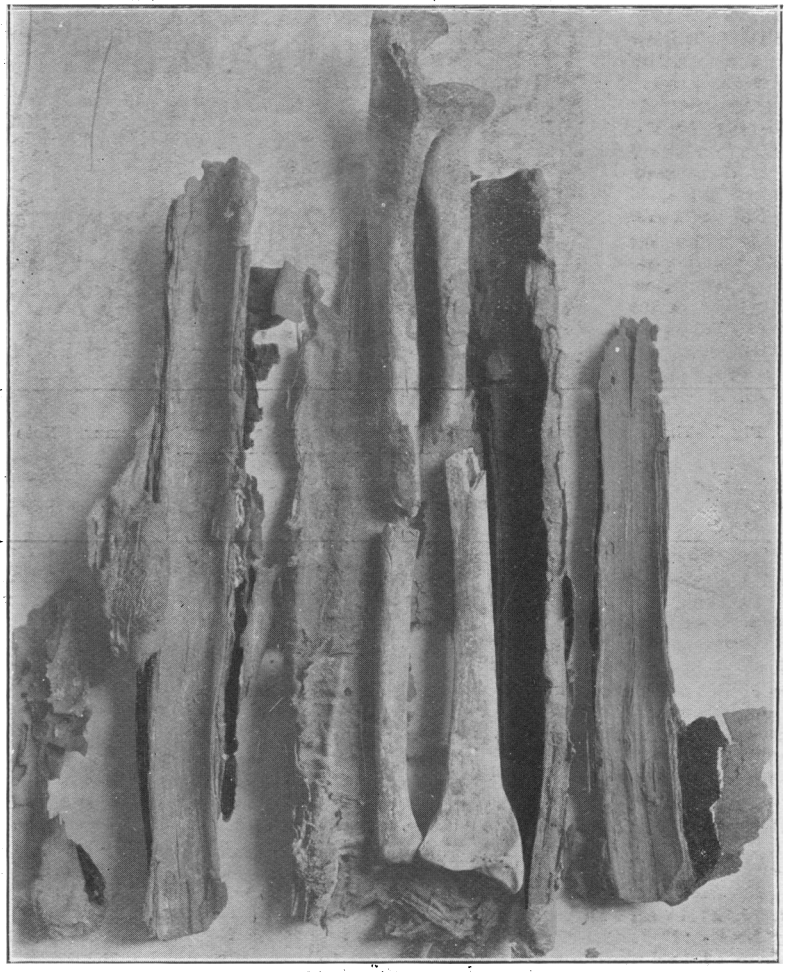

Fig. 6.—Fracture of left forearm set with bark splints. Note the blood-stained mass of vegetable fibre adhering to the ulna.

TO ILLUSTRATE DR. G. ELLIOT SMITH'S PAPER ON ANCIENT SPLINTS.

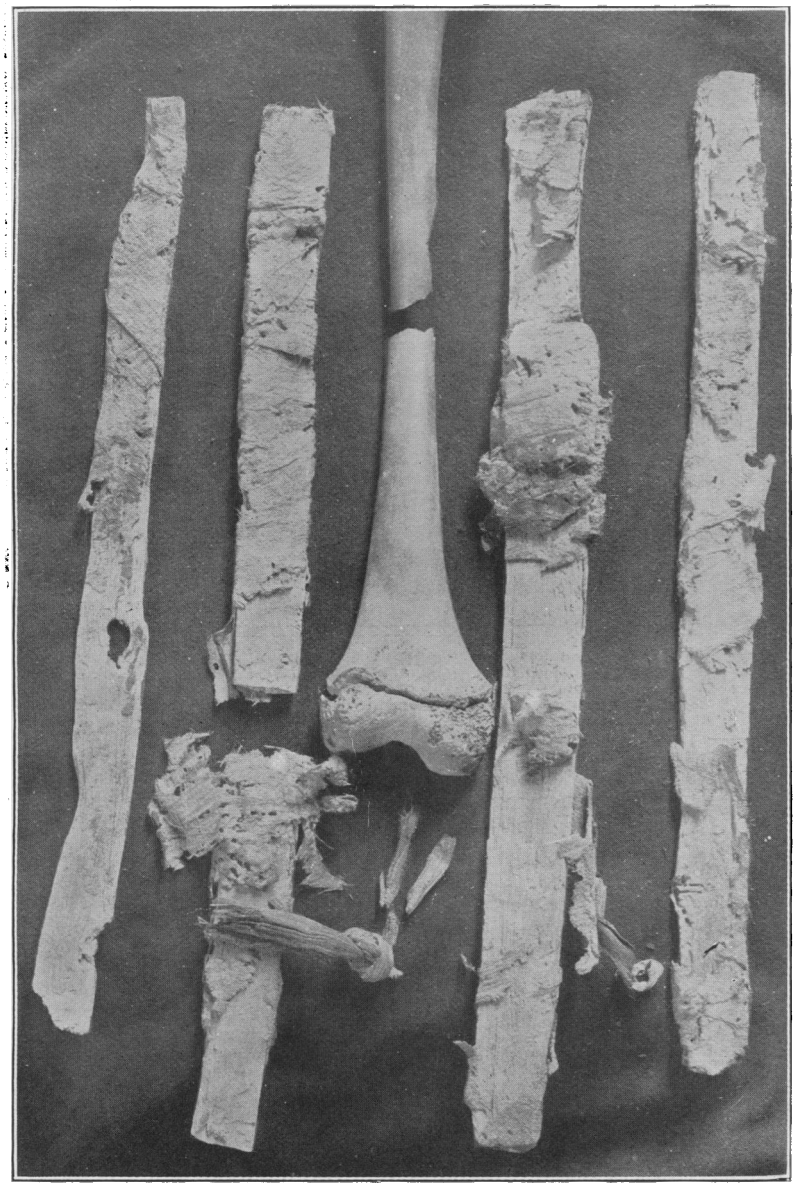

Fig. 3.—The same splints removed and placed alongside the broken femur. Note the pad on the splint to the right of the femur.

Fig. 2.—A set of ancient Egyptian (5th dynasty) splints in position around a fractured femur.

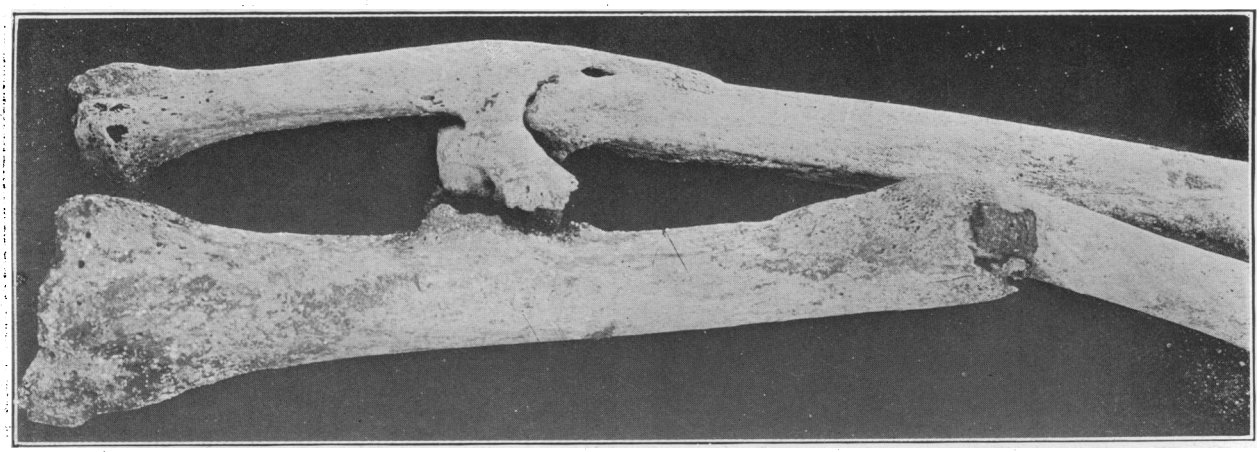

Fig. 8.—An example of vicious union after fracture of the forearm in a prehistoric Egyptian.